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Doorknobs: A Source of Nosocomial Infection?

by Phyllis J. Kuhn, Ph.D.

DISCLAIMER: The following article is based upon independent scientific research and is provided for informational purposes only. The conclusions reached in this article are the opinions of the researchers and authors. U.S. EPA-approved testing demonstrates antimicrobial effectiveness for copper alloys against only the following organisms: *Staphylococcus aureus*, *Enterobacter aerogenes*, *Escherichia coli O157:H7*, *Pseudomonas aeruginosa* and Methicillin resistant *Staphylococcus aureus* (MRSA). References to effectiveness against *Streptococcus* have not been proven by U.S. EPA-approved testing and are only the product of initial exploratory testing. No claim of antimicrobial effectiveness is made, either express or implied, with regard to these organisms. Additionally, copper alloy surfaces are not approved for use in direct food-contact applications.

Sleek and shining stainless steel doorknobs and push plates look reassuringly clean on a hospital door. By contrast, doorknobs and push plates of tarnished brass look dirty and contaminating. But even when tarnished, brass – an alloy typically of 67% copper and 33% zinc – is bactericidal, while stainless steel – about 88% iron and 12% chromium – does little to impede bacterial growth. My interest in comparing hardware on hospital doors arose from in-service training conducted for housekeeping and maintenance personnel at Hamot Medical center. To heighten their awareness of modes of infection, the students were given blood agar plates and instructions on their use, and they returned with cultures from such diverse sources as toilet bowl water (remarkably clean), salad from the employees' cafeteria (heavily colonized), and doorknobs. Brass doorknob cultures showed sparse streptococcal and staphylococcal growth; stainless steel doorknob cultures showed heavy growth of Gram-positive organisms and an array of Gram-negative organisms, including *Proteus* species.

In a later pursuit of the investigation of bacterial growth on metal, small strips of stainless steel, brass, aluminum, and copper were inoculated with broths of *Escherichia coli*, *Staphylococcus aureus*, *Streptococcus* group D, and *Pseudomonas* species. The broths contained approximately 10,000,000 bacteria/ml, a very heavy inoculum. Then the strips were air-dried for 24 hours at room temperature, inoculated onto blood agar plates, and incubated for 24 hours at 37°C.

The results were striking. The copper and brass showed little or no growth, while the aluminum and stainless steel produced a heavy growth of all microbes.

How fast did the microbes die on copper and brass? The test was repeated at drying intervals of 15 minutes, 1 hour, 5 hours, 7 hours, 20 hours, and 24 hours. Brass disinfected itself in seven hours or less, depending on the inoculum size and the condition of the surface of the metal, freshly scoured brass disinfecting itself in one hour. Copper disinfected itself of some microbes within 15 minutes. Aluminum and stainless steel produced heavy growths of all isolates after eight days and growths of most isolates (except *Pseudomonas*) when I ended that part of my investigation after three weeks.

In the next part of the investigation, brass and copper strips were covered with seeded agar and incubated in culture for 24 hours. Because the metals are toxic, I expected a zone of inhibition around the strips, but instead, most of the bacteria piled up by the edges of the strips. Why? According to the Arndt-Shultz law, low levels of poisons tend to stimulate biological activity rather than depress it¹, making an organism's membrane more permeable to entry by nutrients. *Streptococcus* group D, however, grew equally well around and over the metal.

To determine whether bacteria in the clear areas under the seeded agar were killed or merely inhibited, the areas were replica-plated. (This consists of tamping a sterile nubby material like velveteen on a culture plate and inoculating it onto a fresh plate. The technique allows the transferred bacteria to proliferate-if they are still viable.) Replica plates from the stainless steel and aluminum strips grew, while replica plates from the brass and copper strips did not. Scanning electron micrographs of the surfaces of the metals showed that *E. coli* was completely disrupted on the brass while remaining intact on the stainless steel.¹

What are the implications? Culturing a stainless steel knob on a door between a burn unit and an intensive-care unit, I found a multiply resistant *Staphylococcus epidermidis* with a susceptibility pattern identical to that found in the blood of a septic patient in the intensive-care unit. Cultures of wounds of several other patients yielded similar organisms. None of these observations prove cause, of course, but they ought to impress us with the need to take precautions, particularly in the presence of multiply resistant microbes.

Ironically, stainless steel is actually more expensive than steel coated with brass – \$117 vs. \$108 for the hardware for one door, according to one price quotation. If your hospital is being renovated, try to retain old brass hardware or have it repeated; if you have stainless steel hardware, make certain that it is disinfected daily, especially in critical-care areas.

We have known for years that certain metals are toxic to bacteria. It is the application of this knowledge to better infection control that warrants further attention.

Reference

1. Lamanna C. and Mallette MF. Chemical disinfection. In: *Basic Bacteriology, Its Biological and chemical Background*. Baltimore: Williams & Wilkins, 1965, p 897.

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